DEPARTMENT OF APPLIED MATHEMATICS,
UNIVERSITY COLLEGE, UNIVERSITY OF LONDON

DRAPERS' COMPANY RESEARCH MEMOIRS

STUDIES IN NATIONAL DETERIORATION,

I. ON THE RELATION OF FERTILITY IN MAN TO SOCIAL STATUS, AND ON THE CHANGES IN THIS RELATION THAT HAVE TAKEN PLACE DURING THE LAST FIFTY YEARS.

BY
DAVID HERON, M.A.
ST ANDREWS UNIVERSITY AND UNIVERSITY COLLEGE, LONDON

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Studies in National Deterioration from the Drapers' Company Biometric Laboratory, University College, London.

I. ON THE RELATION OF FERTILITY IN MAN TO SOCIAL STATUS, AND ON THE CHANGES IN THIS RELATION THAT HAVE TAKEN PLACE DURING THE LAST FIFTY YEARS. By David Heron, M.A., St Andrews University and University College, London.

I. The present memoir forms part of an investigation undertaken at the suggestion of Professor Karl Pearson, and carried out under his guidance. Its object is to determine to what extent the fall in the number of children in English families is *differential*. To what degree is the reduced fertility of English wives associated with social status, or with conditions which mark poverty, disease, or generally unhealthy and improvident surroundings? Further, if it be possible to shew marked relationships between size of family and social conditions, can it be shewn that these relationships have changed, and if so changed for the better or worse, during the last fifty years?

The topic is clearly one of supreme importance for the problem of national survival in the struggle of communities. It has been shewn by Pearson* that 25 per cent. of the married population produce 50 per cent. of the next generation, and this conclusion has recently been confirmed by Powys†. It thus becomes of the first importance to determine whether that 25 per cent. is the better or worse portion of the community. The inheritance of both physical and mental characters hardly admits today of dispute; it is only the manner or intensity of inheritance which calls for discussion.

Notwithstanding its high infantile mortality, Pearson and Powys both conclude that it is the artizan class which contributes the largest relative number to the population‡. In the present investigation I propose to bring forward evidence shewing the nature and conditions of the more fertile classes of the community.

My data are drawn from two sources, national or municipal statistical publications and a series of schedules relating to size of families in successive generations issued by Professor Pearson and placed by him at my disposal. In this first instalment of my inquiry, I have confined my attention to the former material and to the metropolis, but I hope without undue delay to supplement these results not only by those for other districts but by a comparison of such districts among themselves*.

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* Reproductive Selection: *The Chances of Death*, Vol. I. p. 80, *et seq.* p. 92.

† On Fertility, Duration of Life and Reproductive Selection: *Biometrika*, Vol. IV. Pt. III. p. 250.

‡ Pearson, *loc. cit.* p. 100. Powys, *loc. cit.* p. 285.

II. In dealing with the metropolis I have used the following sources of statistical information:—

(1) Report of the Registrar General for the year 1901.

(2) Census of England and Wales, 1901: County of London.

(3) Report of the Medical Officer of Health of the County of London for the year 1901, contained in "London Statistics, 1902–3."

(4) Report of the Registrar General for the year 1851.

(5) Census of England and Wales, 1851.

From these works we can determine for 1901 the age distribution of the married women in each of twenty-seven districts. It is of course well known that the birth-rate even if calculated on the number of married women of a community is not an absolutely true test of the fertility of the women. It is necessary that we should know the proportions of each age group within the total number of such women. But while I shall endeavour to shew how the influence of the age of the married women to some extent may be allowed for, I wish to point out that it is not essential to my conclusions. If we divide the community up into any groups depending upon a classification according to any character such as wealth, social status, health, or cleanliness, and shew that the birth-rate is correlated with such a character, it is not destructive of the argument to point out that the distribution of ages of the wives in the sub-groups also varies. For example, the size of families is less in the professional than in the artizan classes. To shew that the age distribution of wives is different in the two classes may account for a certain part of the result—it does not account for all—and may perhaps aid us in seeking a remedy. But it does not touch the argument that the educated classes are providing less than their full quota to the next generation. I have tried basing the birth-rate on various sections of the married women, but I find that it makes very little difference in the correlation coefficients I have calculated. I accordingly determined to take all married women between the extreme limits of reproductivity, or as the ages are given in five year periods, between 15 and 54†. Taking the legitimate births only I have calculated (i) the birth-rate for 100 married women between 15 and 54 in each district.

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* Since I started this investigation not only has Powys' paper been published but papers on allied matters by Newsholme & Stevenson and G. U. Yule have been read before the *Royal Statistical Society*, Dec. 19, 1905. They do not however follow the lines of research here adopted and my conclusions and methods are not in any way dependent upon theirs.

† Powys, *loc. cit.*, has recently noted more than 30 cases of births attributed to women of ages 50 to 58.

For the 1851 census, the age distributions are not given for each district (this feature being first introduced in 1861), but only the total number of married women of 20 and upwards, thus a few possibly reproductive wives are excluded and wives of ages long past the child-bearing period must perforce be included. The comparable correlations from the 1901 census were then recalculated upon this basis of wives aged 20 and upwards. The correlation coefficients were found to be affected by the change only in about the third place of decimals*. For our present purpose then, the exact age distribution of the married women is not of primary importance.

In the next place I took the following characters as measures of wealth and education, (ii) the number of professional men per 1000 occupied males, (iii) the number of female domestic servants per 100 females aged 15 and upwards, (iv) the number of female domestic servants per 100 families.

I took the following characters as measures of poverty and lack of culture, (v) the number of general labourers per 1000 occupied males, and (vi) the number of pawnbrokers, general dealers, etc. per 1000 occupied males. The proportion of general labourers may be taken as a measure of how far the district is the abode of the lowest class of labour, while many of the pawnbrokers, etc. are called into being and survive only by illicit forms of trade in the poorer districts, and their presence certainly indicates a high degree of improvidence.

I next turned to child labour and determined (vii) the number of boys and girls aged 10 to 14 employed per 100 boys and girls between those ages.

Turning now more directly to thriftlessness and poverty, I took out (viii) the number per 100 in each district living more than 2 in a room, and (ix) the number of deaths in each district of children under 1 year per 1000 births.

Following up the health conditions, and considering phthisis as a disease which, like infantile mortality, largely marks unhealthy occupations, bad housing and poor general environment, I obtained (x) the deaths from phthisis per 100,000 of the population. This table, and the other tables of death-rates, were obtained from the Report of the Medical Officer of Health for the County of London and are "corrected for institutions," *i.e.* deaths occurring in any institution are credited to the proper district and not merely to the district in which the death was registered.

To compare this with a disease not *à priori* so closely related to insanitary conditions and general degeneracy, I selected cancer and obtained (xi) the number of deaths from cancer per 100,000 of population. Through the kindness of Sir Shirley F. Murphy, Medical Officer of Health for London, I was enabled to proceed farther with the consideration of cancer and obtained (xii) the number of male deaths from cancer per 100,000 males, and (xiii) the number of female deaths from cancer per 100,000 females.

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* Cf. Table VI.

TABLE I. A. For the Year 1901.

Metropolitan Borough	Legitimate births per 100 wives aged 15—54	Legitimate births per 100 wives aged 20 and upwards	Professional men per 1000 occupied males	Female domestic servants per 100 females	Female domestic servants per 100 families	General labourers per 1000 occupied males	Pawnbrokers, General dealers, etc., per 1000 occupied males	Children aged 10—14 employed per 100 children aged 10—14	Number per 100 of total population living more than 2 in a room	Infants under 1 year dying per 1000 births	Mean age of wives aged 15—54	Deaths from phthisis per 100,000	Deaths from cancer per 100,000	Male deaths from cancer per 100,000 males	Female deaths from cancer per 100,000 females	Children aged 2—4 per 100 wives aged 15—54	Children aged 5—14 per 100 wives aged 15—54	Children aged 13—15 per 100 wives aged 15—54
Battersea	17·39	15·54	32·63	7·90	12·51	5·77	6·67	10·68	10·88	163	36·91	147	81	59·9	101·0	56·03	126	36·7
Bermondsey	21·86	19·26	9·85	4·18	6·44	9·05	6·78	14·92	19·67	169	36·64	176	67	64·5	70·9	64·68	145	40·6
Bethnal Green	22·74	20·37	6·78	3·56	5·59	4·69	9·27	16·55	29·62	153	36·28	216	86	71·0	99·5	68·50	146	40·6
Camberwell	17·76	15·55	33·21	8·73	14·96	3·32	6·68	9·91	9·64	142	37·19	146	97	69·9	121·8	57·82	135	39·5
Chelsea	14·97	12·95	38·92	25·36	47·46	6·19	6·89	8·61	14·43	138	37·51	168	91	70·1	107·3	48·04	112	33·1
Deptford and Greenwich	18·79	16·53	26·13	11·52	19·20	8·79	5·94	8·85	8·69	138	36·96	118	75	72·1	80·1	59·30	135	39·5
Finsbury	23·10	20·89	13·59	5·28	7·87	4·33	7·28	15·13	35·21	142	36·60	223	78	58·1	97·0	58·73	130	38·4
Fulham......................	18·27	16·69	34·73	10·93	17·44	5·37	5·60	8·93	10·85	152	36·36	137	88	71·2	104·6	57·87	118	32·0
Hackney	17·87	15·57	33·19	9·98	17·76	3·03	5·67	12·06	10·18	135	36·94	148	80	66·2	92·3	56·19	128	37·6
Hammersmith	16·69	14·66	37·35	10·96	18·68	6·90	6·23	8·90	11·75	168	36·89	140	84	66·4	100·8	53·65	121	34·7
Hampstead	13·52	11·71	82·94	33·08	79·88	2·29	3·18	7·92	6·36	104	37·61	94	96	97·8	95·6	46·76	113	35·7
Holborn.....................	19·52	17·44	58·03	12·16	20·70	6·72	7·47	13·96	25·04	124	36·60	277	100	98·3	100·1	43·42	101	32·2
Islington....................	16·90	14·89	30·40	9·24	15·26	3·40	5·86	12·44	17·00	140	36·83	152	91	68·4	112·1	52·26	116	33·8
Kensington	14·64	12·67	67·04	32·66	74·92	5·11	7·28	10·44	14·84	163	37·79	137	112	79·6	133·0	47·10	109	33·8
Lambeth	18·05	15·80	35·60	10·65	17·63	4·69	7·09	9·98	12·22	139	36·92	166	99	77·9	116·3	52·62	119	34·6
Lewisham..................	16·46	14·34	52·22	18·59	35·77	4·29	3·42	8·00	2·68	129	37·24	90	95	59·9	124·4	54·21	124	37·2
Paddington	15·31	13·34	53·26	24·00	46·65	2·89	4·30	9·55	13·57	136	37·33	110	103	84·4	117·8	46·78	105	31·8
Poplar	21·85	19·34	10·26	4·90	7·96	10·54	6·45	12·00	16·41	165	36·77	180	73	62·5	83·3	63·53	143	41·0
St Marylebone	17·62	15·52	51·15	23·99	46·02	4·45	5·80	11·73	21·12	107	37·19	182	104	115·7	94·2	46·05	102	32·5
St Pancras..................	16·32	14·41	32·35	10·10	15·90	3·24	7·01	11·80	23·98	154	36·75	184	88	74·4	100·8	50·50	115	33·4
Shoreditch	21·26	19·04	6·44	3·55	5·50	4·78	9·40	16·22	29·95	197	36·48	215	81	77·4	84·3	61·63	134	38·7
Southwark..................	19·91	18·00	14·25	4·88	7·33	7·62	10·65	13·01	22·35	168	36·37	248	86	80·4	92·3	57·78	126	36·2
Stepney.....................	23·99	21·73	11·99	5·31	8·60	7·08	9·00	12·10	33·21	163	35·82	210	73	65·7	81·1	67·64	141	38·5
Stoke Newington.........	14·25	12·14	46·48	14·56	27·58	1·28	4·45	9·85	5·53	115	37·36	134	92	44·2	129·3	47·97	109	34·4
Wandsworth...............	16·57	14·53	56·32	17·84	34·44	4·38	5·18	8·51	4·45	132	37·14	115	89	63·6	111·5	54·18	122	35·6
Westminster	12·55	11·04	43·25	27·28	53·36	3·38	5·38	12·27	13·04	135	37·37	187	83	78·9	85·7	40·52	93	29·9
Woolwich..................	18·20	16·25	14·63	9·02	14·12	10·25	3·36	10·27	6·59	129	36·47	175	71	49·0	94·8	56·75	126	36·7

I then turned to pauperism as judged by the number of persons relieved on 1st January, 1901—not by any means a satisfactory measure of the actual state of affairs. Here only 20 districts are available owing to the difference between the Metropolitan Boroughs and the Poor Law Unions. This made it necessary to give (xiv) a table of the number of legitimate births per 100 wives aged 15—54 for each of those 20 districts. I then determined (xv) the number of all classes of paupers relieved on 1st January, 1901, per 1000 of the population and (xvi) the number of lunatic paupers similarly relieved per 1000 of the population.

TABLE I. B. For the Year 1901.

Metropolitan Borough	Legitimate births per 100 wives aged 15—54	Total number of all classes of paupers relieved on 1st Jan. 1901, per 1000 of population	Total number of lunatic paupers relieved on 1st Jan. 1901, per 1000 of population
Battersea and Wandsworth	16·94	16·40	2·16
Bermondsey	21·86	56·30	3·92
Bethnal Green	22·74	28·00	4·32
Camberwell	17·76	31·45	2·73
Chelsea	14·97	35·68	4·59
Fulham	18·27	13·02	1·93
Hackney and Stoke	17·18	27·10	3·57
Hammersmith	16·69	14·91	2·45
Hampstead	13·52	8·98	1·38
Islington	16·90	24·78	2·66
Kensington	14·64	20·90	3·48
Lambeth	18·05	23·20	3·35
Paddington	15·31	12·03	2·34
Poplar	21·85	37·80	3·31
St Marylebone	17·62	31·74	5·08
St Pancras	16·32	29·97	3·94
Shoreditch	21·26	25·67	3·95
Southwark	19·91	31·34	4·93
Stepney	23·99	28·52	3·91
Westminster	12·55	37·44	3·78

TABLE II. For the Year 1851.

Registration District	Legitimate births per 100 wives aged 20 and upwards	Female domestic servants per 100 females	Professional men per 100 males	General labourers per 1000 males	Pawnbrokers, General dealers, etc., per 1000 males	Infants under 1 year dying per 1000 births
Bermondsey	21·11	5·38	·84	7·43	9·21	157
Bethnal Green	20·75	3·49	·88	4·44	16·06	125
Camberwell	18·68	18·29	3·51	5·11	9·30	131
Chelsea	17·95	15·60	2·89	8·04	9·64	158
Clerkenwell	19·57	8·91	3·05	4·21	12·63	140
East London	18·76	11·79	1·42	5·38	28·62	185
Greenwich	18·17	10·24	1·20	8·59	9·42	144
Hackney	19·07	19·34	3·81	5·94	21·09	132
Hampstead	16·20	29·94	7·15	9·49	14·59	132
Holborn	16·69	12·26	5·64	7·14	11·99	180
Islington	18·66	16·77	4·85	5·49	17·53	171
Kensington	18·01	27·35	5·13	7·18	12·73	144
Lambeth	18·86	14·14	2·92	6·58	18·09	156
Lewisham	18·66	20·31	2·96	7·95	11·19	111
Newington	19·23	9·17	2·63	5·35	18·44	142
Poplar	21·62	6·98	·74	15·43	6·58	140
Rotherhithe	19·41	4·91	·74	13·90	6·01	159
St George, Hanover Square	15·47	34·70	4·49	3·74	5·15	140
St George in the East	19·55	5·45	·82	10·59	10·02	154
St George, Southwark	18·33	7·09	1·69	7·24	18·67	187
St Giles	18·71	19·12	4·81	8·80	27·47	184
St James, Westminster	15·72	25·10	3·59	2·29	10·07	153
St Luke	22·99	7·12	1·53	6·09	15·27	131
St Martin in the Fields	15·26	23·18	3·44	3·03	11·29	151
St Marylebone	16·77	22·75	3·40	6·26	11·57	171
St Olave, Southwark	16·02	8·63	1·74	20·27	6·10	257
St Pancras	17·65	15·09	4·54	4·38	14·20	156
St Saviour, Southwark	19·40	9·08	1·72	9·34	8·71	190
Shoreditch	20·93	5·62	1·62	4·35	13·58	140
Stepney	18·13	7·26	1·27	9·63	14·07	158
Strand	16·51	13·08	4·84	3·13	11·23	151
Wandsworth	18·12	22·20	3·16	8·67	9·62	134
West London	16·12	13·06	3·75	6·67	10·77	190
Westminster	16·93	10·97	1·96	9·54	12·02	173
Whitechapel	19·49	8·50	·77	12·39	31·34	199

The preceding Tables I. A. and B. give the values of the above characters for 27 Metropolitan districts, except in the case of pauperism when only 20 districts are available, and gives in addition the mean age of the married women in each district and the number of children at three groups of ages: 2—4, 5—14, and 13—15, per 100 wives aged 15—54.

In Table II. is given like information, where it was possible to obtain it, for the year 1851. Here 35 districts are available. Upon the material in those tables my correlation coefficients are based. In every case the constants were found directly from the moments and products and without grouping.

TABLE III. A. For the Year 1901.

Character	Mean	Standard Deviation	Coefficient of Variability
Legitimate births per 100 married women aged 15—54	18·01 ± ·38	2·94 ± ·27	16·34 ± 1·54
Legitimate births per 100 wives aged 20 and upwards	15·93 ± ·36	2·79 ± ·26	17·52 ± 1·66
Professional men per 1000 occupied males	34·56 ± 2·53	19·46 ± 1·79	56·31 ± 6·61
Female domestic servants per 100 females	13·34 ± 1·13	8·73 ± ·80	65·43 ± 8·18
Female domestic servants per 100 families	25·17 ± 2·62	20·18 ± 1·85	80·17 ± 11·13
General labourers per 1000 occupied males	5·33 ± ·30	2·35 ± ·22	44·02 ± 4·85
Pawnbrokers, General dealers, etc., per 1000 occupied males	6·38 ± ·23	1·80 ± ·17	28·21 ± 2·79
Children aged 10—14 employed per 100 children aged 10—14	11·28 ± ·31	2·43 ± ·23	21·56 ± 2·07
Number per 100 of population living more than 2 in a room	15·90 ± 1·15	8·83 ± ·81	55·53 ± 6·48
Infants under 1 year dying per 1000 births	144·44 ± 2·70	20·64 ± 1·90	14·29 ± 1·34
Deaths from phthisis per 100,000 living	165·70 ± 5·82	44·84 ± 4·12	27·06 ± 2·66
Deaths from cancer per 100,000 living	87·52 ± 1·42	10·89 ± 1·00	12·46 ± 1·16
Male deaths from cancer per 100,000 males living	72·13 ± 1·90	14·65 ± 1·35	20·32 ± 1·94
Female deaths from cancer per 100,000 females living	100·92 ± 2·08	16·02 ± 1·47	15·88 ± 1·49
Mean age of wives aged 15—54	36·90 ± ·06	·4476 ± ·0411	1·213 ± ·113
Children aged 2—4 per 100 wives aged 15—54	54·46 ± ·92	7·10 ± ·65	13·04 ± 1·22
Children aged 5—14 per 100 wives aged 15—54	122·00 ± 1·69	13·80 ± 1·27	11·31 ± 1·05
Children aged 13—15 per 100 wives aged 15—54	35·88 ± 3·91	3·01 ± ·28	8·38 ± ·78
*Legitimate births per 100 married women aged 15—54	17·92 ± ·46	3·05 ± ·33	16·77 ± 1·83
*Total number of paupers per 1000 of the population	26·76 ± 1·57	10·42 ± 1·11	38·94 ± 4·75
*Total number of lunatic paupers per 1000 of the population	3·39 ± ·15	·99 ± ·11	29·14 ± 3·36

* For 20 districts only.

III. The mean standard deviation and coefficient of variability of each character dealt with, together with their probable errors, are given in Table III.

The high coefficients of variation shew how markedly our tests of social status give a real measure of the differential conditions of the various districts. It is only in the mean age of wives and the number of children at each age that the variability is relatively low.

TABLE III. B. For the Year 1851.

Character	Mean	Standard Deviation	Coefficient of Variability
Legitimate births per 100 married women aged 20 and upwards	18·39 ± ·20	1·79 ± ·14	9·73 ± ·79
Female domestic servants per 100 females	14·08 ± ·88	7·75 ± ·62	55·04 ± 5·62
Professional men per 1000 males	28·43 ± 1·86	16·29 ± 1·31	57·39 ± 5·96
General labourers per 1000 males	7·54 ± ·42	3·66 ± ·29	48·54 ± 4·75
Pawnbrokers, General dealers, etc., per 1000 males	13·84 ± ·78	6·10 ± ·49	44·08 ± 4·19
Infants under 1 year dying per 1000 births	157·89 ± 3·08	27·04 ± 2·18	17·11 ± 1·42

In Table IV. such comparative data are given as were possible for 1851 and 1901. This table brings forcibly before us the change in the birth-rate since 1851.

TABLE IV. Comparison of 1851 and 1901.

Character	Years	Means	Standard Deviations	Coefficients of Variability
Legitimate births per 100 wives aged 20 and upwards	1851	18·39 ± ·20	1·79 ± ·14	9·73 ± ·79
	1901	15·93 ± ·36	2·79 ± ·26	17·52 ± 1·66
Female domestic servants per 100 females	1851	14·08 ± ·88	7·75 ± ·62	55·04 ± 5·62
	1901	13·34 ± 1·13	8·73 ± ·80	65·43 ± 8·18
Professional men per 1000 males	1851	28·43 ± 1·86	16·29 ± 1·31	57·39 ± 5·96
	1901	34·56 ± 2·53	19·46 ± 1·79	56·31 ± 6·61
General labourers per 1000 males	1851	7·54 ± ·42	3·66 ± ·29	48·54 ± 4·75
	1901	5·33 ± ·30	2·35 ± ·22	44·02 ± 4·85
Pawnbrokers, General dealers, etc., per 1000 males	1851	13·84 ± ·78	6·10 ± ·49	44·08 ± 4·19
	1901	6·38 ± ·23	1·80 ± ·17	28·21 ± 2·79
Infants under 1 year dying per 1000 births	1851	157·89 ± 3·08	27·04 ± 2·18	17·11 ± 1·42
	1901	144·44 ± 2·70	20·64 ± 1·90	14·29 ± 1·34

IV. The problem of the influence of social status on the birth-rate can now be discussed, by correlating the characters as given in Table I. I would here remind the reader that the coefficient of correlation must lie numerically between 0 and 1. Unity marks a complete causal relationship; correlations between ·00 and ·25 may be spoken of as small, although such relationships may be quite sensible; correlations between ·25 and ·50 are moderate; when between ·5 and ·75 we may speak of them as large, and if between ·75 and 1, as very large. These are of course merely rough descriptions, but they may be of service to the lay reader when he attempts to appreciate the meaning of the various coefficients here found. A negative correlation simply means that one variable instead of increasing, decreases on the average with the increase of the second.

We will now examine first the influence of those characters which mark ease and culture on the birth-rate.

We find:

Correlation between proportion of occupied males who are engaged in professional work:

$$= -\cdot781 \pm \cdot051.$$

Correlation between number of female domestic servants kept and birth-rate:

$$= -\cdot764 \pm \cdot054.$$

In other words, in those districts where the professional classes are most numerous and where many domestic servants are kept, there the married women have fewest children. The relation is an exceedingly close one and is obviously most significant. In the above case the number of female domestic servants per 100 families was taken, but for purposes of comparison with 1851 it was necessary to correlate the birth-rate with the number of female domestic servants per 100 females, and this furnishes us with a useful check. I found

Correlation between birth-rate and number of female domestic servants per 100 females:

$$= -\cdot802 \pm \cdot046;$$

again a result of great significance.

In the next place I proceeded to consider signs of poverty. I found

Correlation between proportion of males engaged in the lowest type of labour and the birth-rate:

$$= +\cdot517 \pm \cdot095.$$

Correlation between the presence of pawnbrokers and allied trades and the birth-rate:

$$= +\cdot618 \pm \cdot080.$$

Correlation between amount of child-employment and the birth-rate:

$$= +\cdot660 \pm \cdot073.$$

Correlation between all kinds of pauperism and the birth-rate*:

$$= +\cdot 199 \pm \cdot 145.$$

Now these results are not so high as those connecting prosperity and culture with a low birth-rate, but they are hardly less important in their social significance. Where the labour is of the lowest type, where poverty leads to the pawnbroker and forces the child at the earliest possible age into employment, there the married women have most offspring.

In the next place I take conditions which are largely significant of the physical health of the parents. I find

Correlation between overcrowding and the birth-rate:

$$= +\cdot 697 \pm \cdot 067.$$

Correlation between prevalence of phthisis and the birth-rate:

$$= +\cdot 594 \pm \cdot 084.$$

Correlation between the extent of pauper lunacy and the birth-rate:

$$= +\cdot 336 \pm \cdot 134.$$

In other words, the worse the sanitary conditions under which the people live, and the worse their physical and mental health, the higher is the birth-rate.

We come now to consider the relation between the birth-rate and the prevalence of cancer, and here we get a somewhat unexpected result. Taking both sexes together, we find

Correlation between the birth-rate and death-rate from cancer:

$$= -\cdot 563 \pm \cdot 089.$$

In other words, the district with a low birth-rate suffers most from cancer.

This seemed to require further investigation; accordingly I obtained separate death-rates for the sexes, and found:

Correlation between prevalence of cancer among females and the birth-rate:

$$= -\cdot 535 \pm \cdot 093.$$

Correlation between prevalence of cancer among males and the birth-rate:

$$= -\cdot 156 \pm \cdot 127.$$

Thus the prevalence of cancer in women appears to be more closely associated with the birth-rate than is the case for men, and is possibly due to the infrequency of child-bearing itself.

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* This is the lowest coefficient obtained. I believe it to be largely due to three causes, (*a*) the great difficulty in proportioning the pauperism to the districts, (*b*) the relative comfort provided by different poor law guardians for those under their care, (*c*) the differential amount of charitable doles provided for the 'unemployed' and others in different districts. I have tried separating the different classes of pauperism, but without reaching any marked increase in correlation.

Testing the matter directly, we find:

Correlation between prevalence of cancer among women and the proportion of domestic servants:

$$= + \cdot 404 \pm \cdot 109.$$

Correlation between prevalence of cancer among men and the proportion of domestic servants:

$$= + \cdot 422 \pm \cdot 107.$$

And still further to throw light on the matter, we find:

Correlation between prevalence of cancer among women and proportion of professional men:

$$= + \cdot 553 \pm \cdot 088.$$

Correlation between prevalence of cancer among men and proportion of professional men:

$$= + \cdot 447 \pm \cdot 104.$$

These results seem to indicate that the conditions of prosperity and culture which lead to a low birth-rate also conduce to a high cancer death-rate. In other words, cancer cannot, like phthisis, be taken as a measure of that unhealthy environment with which a high birth-rate seems to be associated.

V. We now reach a point which to some may appear paradoxical. To those who have been at all in contact with the poorer life of our great cities, no single factor will appear more characteristic of the worst type of the community than excessive infantile mortality. Where there is greatest poverty, greatest drunkenness, least thrift, there the carelessness of child life is greatest, and there the infantile mortality reaches its largest proportions. I doubt if there is any better measure of the undesirability of a class and its unsuitability for reproducing its kind, than the extent of the infantile mortality within it.

If we correlate infantile mortality with the birth-rate, we find:

Correlation between the proportion of children dying under 1 year and the birth-rate:

$$= + \cdot 500 \pm \cdot 097.$$

In other words, in districts where there is the maximum of carelessness with regard to child-life, there the birth-rate is highest. Where the mothers and fathers have the maximum of undesirability there is produced a maximum of children.

It may be said, however, that surely this is, from the standpoint of national efficiency, self-curative. The most children are born and the most die. The answer can, however, be given only after a study of gross and net fertility. I accordingly have investigated the correlation between the number of surviving children of different ages per 100 wives aged 15—54 and the birth-rate. In all cases the coefficients of correlation are positive and substantial. Thus:

Correlation between infantile mortality and number of children between 2 and 4 per 100 wives:

= + ·588 ± ·085.

Correlation between infantile mortality and number of children between 5 and 14 per 100 wives:

= + ·541 ± ·092,

and Correlation between infantile mortality and number of children aged 13 to 15 per 100 wives:

= + ·391 ± ·110.

It will thus be apparent that even in the districts where there is the greatest carelessness of, or the worst environment for, child-life, there the net fertility is still greatest.

The results so far discussed are given together in the following Table V.

TABLE V. Correlation of the Birth-rate with social and physical characters of the population. For the Year 1901.

Characters correlated	Correlation coefficient
Birth-rate and proportion of occupied males engaged in professional occupations	− ·781 ± ·051
Birth-rate and number of female domestic servants per 100 females	− ·802 ± ·046
„ „ „ „ „ „ 100 families	− ·764 ± ·054
Birth-rate and General labourers per 1000 males	+ ·517 ± ·095
Birth-rate and Pawnbrokers, etc., per 1000 males	+ ·618 ± ·080
Birth-rate and proportion of children aged 10—14 employed	+ ·660 ± ·073
Birth-rate and proportion living more than 2 in a room	+ ·697 ± ·067
Birth-rate and number of infants under 1 year dying per 1000 births	+ ·500 ± ·097
Birth-rate and deaths from phthisis per 100,000	+ ·594 ± ·084
„ „ „ cancer „	− ·563 ± ·089
Birth-rate and male deaths from cancer per 100,000	− ·156 ± ·127
„ female „ „ „	− ·535 ± ·093
Birth-rate and number of all classes of paupers per 1000	+ ·199 ± ·145
„ „ „ lunatic paupers per 1000	+ ·336 ± ·134
Female deaths from cancer and professional men	+ ·553 ± ·088
„ „ „ domestic servants	+ ·404 ± ·109
Male deaths from cancer and professional men	+ ·447 ± ·104
„ „ „ domestic servants	+ ·422 ± ·107
Infantile mortality and children aged 2—4 per 100 wives	+ ·588 ± ·085
„ „ „ „ 5—14 „	+ ·541 ± ·092
„ „ „ „ 13—15 „	+ ·391 ± ·110
Birth-rate and mean age of wives aged 15—54	− ·834 ± ·040

These results shew that in every test I have made of the socially or physically undesirable character of a district, with the single exception of cancer, there the birth-rate is correlated, and very substantially correlated, with the intensity of this character. The wives in the districts of least prosperity and culture have the largest families, and the morally and socially lowest classes in the community are those which are reproducing themselves with the greatest rapidity.

It remains to be considered how far different methods of determining fertility might modify or throw light on other aspects of these conclusions.

VI. The question of the age-grouping of the wives on which the birth-rates are based seemed to be of great importance.

The married women may theoretically be divided into those of possibly reproductive ages and those of non-reproductive ages, but it is difficult to say, without taking a very high upper limit for the age of the possibly reproductive wives, what division would satisfy those conditions. As I have said, the birth-rates of the previous discussion are based upon the number of legitimate births per 100 wives aged 15—54. Such a basis of calculation is not possible in the 1851 Census, where the numbers of wives are only given of age 20 and upwards. Hence any coefficient of correlation for 1901, which was to be compared with a similar coefficient for 1851, had to be recalculated on the basis of wives aged 20 and upwards. The result of computing the birth-rates on the two different age-groupings is shewn in Table VI. It was found that only in the third place of decimals did the correlation coefficients determined differ. It will therefore, I think, be evident that the conclusions drawn are not in any way dependent upon the manner in which the birth-rate is determined from the age-grouping of the wives, and the particular grouping employed is not here of the first importance.

TABLE VI. Comparison of Correlations found by different methods of computing Birth-rates. For the Year 1901.

Correlation of Birth-rate and	Birth-rate based on	
	Wives aged 15—54	Wives 20 and upwards
Domestic servants per 100 females	− ·802 ± ·046	− ·801 ± ·046
Professional men per 1000 males.........	− ·781 ± ·051	− ·783 ± ·050
General labourers per 1000 males	+ ·517 ± ·095	+ ·518 ± ·095
Pawnbrokers, etc., per 1000 males	+ ·618 ± ·080	+ ·627 ± ·079
Deaths under 1 year per 1000 births ...	+ ·500 ± ·097	+ ·506 ± ·097

VII. I have already pointed out that question of the age at marriage is not one which closely affects the present investigation. For if poverty and bad environment generally lead to early marriage, and prosperity and culture to late marriage, and thus differentiation of the birth-rate arises, it may help us to a remedy, but it does not affect the conclusion that reproductive selection is at present working in the direction of national degeneracy. At the same time it seems of interest to consider how far the varying fertility of wives of different ages is concerned with the results we have just been considering. We have not unfortunately the data necessary for determining the correlation between age at marriage and birth-rate. All we can find from the data at our disposal is the mean age of any portion of the married women—for example of the women of possibly reproductive ages. I considered it best to calculate for each district the mean age of the married women aged 15—54, and take this as a rough measure of the earliness or lateness, as the case might be, of marriage in each district. This result is of course rendered less reliable by differential death-rates. Women in the higher class districts have a somewhat longer average life than those in the poorer districts, and this, although we do not include wives over 54, may somewhat raise the mean age of possibly reproductive wives in districts of the former class. But this appeared to me the best way of allowing for age differences in marriage with the available material. I correlated these mean ages of possibly reproductive wives with various conditions and obtained the results given in Table VII.

TABLE VII. Correlation of mean age of wives of possibly reproductive ages and various characters marking social status. For the Year 1901.

Character correlated with mean age	Correlation coefficient
Domestic servants per 100 females	+ ·815 ± ·044
Domestic servants per 100 families	+ ·823 ± ·042
Professional men per 1000 males	+ ·768 ± ·053
General labourers per 1000 males	− ·455 ± ·103
Pawnbrokers, etc., per 1000 males	− ·553 ± ·090
Children 10—14 employed per 100 children 10—14	− ·534 ± ·093
Number living more than 2 in a room per 100 population	− ·607 ± ·082
Births per 100 wives aged 15—54	− ·834 ± ·040

Now it will be seen at once that these are very considerable correlations, and that they are all of the same sign and character as have been found by correlating the birth-rate with the same social conditions. But it would be entirely wrong to at once rush to the conclusion that difference of age at marriage is the source of the whole of the relationship between a high birth-rate and a low social status. We might as well argue that because a child is like its maternal grandfather, and also like its paternal grandfather, therefore the resemblance to the one is its source of resemblance to the other.

The striking correlations we have found between the characters measuring social status and the mean age of the married women are indeed very remarkable when we note how very little the mean age varies from district to district, and of course the smallness of the variation is an illustration of the general principle of the complete independence of variation and correlation. Still when emphasis is frequently laid on the postponement of marriage as one of the sources upon which the reduced fertility of the professional classes depends, it is as well to note how very marked results can be associated with very slight differences in the mean age of reproductive wives*.

The only manner in which we can actually measure the influence of age in this question of birth-rate and social status is to determine the coefficients of partial correlation. If r_{32}, r_{13} and r_{12} are the correlation coefficients between three variables, then the partial correlation coefficient between the first and second variables for a constant value of the third is known to be

$$\frac{r_{12} - r_{13}r_{23}}{\sqrt{1 - r_{13}^2}\sqrt{1 - r_{23}^2}}.$$

But if the subscript 1 denote the birth-rate, 2 a character marking social status, and 3 the mean age of the wives of a district, then the above partial coefficient shews the reduction in the total coefficient (r_{12}) by taking a constant mean age of the married women—in other words it shews what effect remains after we have allowed for the influence of varying age. All the necessary values of r_{12} and r_{23} have already been found. The correlation between birth-rate and mean age of wives was found to be

$$= -\cdot 834 \pm \cdot 040.$$

TABLE VIII. Effect of mean age of wives on Coefficients of Correlation. For the Year 1901.

Character with which the Birth-rate is correlated	Total Correlation	Partial Correlation
Domestic servants per 100 females	– ·802	– ·383
„ „ „ 100 families	– ·764	– ·248
Professional men per 1000 males	– ·781	– ·400
General labourers per 1000 males	+ ·517	+ ·280
Pawnbrokers, etc., per 1000 males	+ ·618	+ ·342
Children 10—14 employed per 100 children aged 10—14	+ ·660	+ ·461
Number per 100 living more than 2 in a room	+ ·697	+ ·436
Mean arithmetical value	·691	·364

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* Powys has already pointed out that the average age at marriage of the professional class is 30·22 years, and that of the industrial class is 28·57 years, a difference of only 1·65 years. *Biometrika*, Vol. IV. Pt. 3, p. 283.

The partial correlation coefficients were then calculated, and are given in Table VIII. together with the total correlation coefficients.

It is apparent from an examination of this table that the differences in mean age of the possibly reproductive wives which accompany various changes in social status account for a little less than half the observed relationship between birth-rate and these variations in social status. The earlier marriages of the less educated, the less thrifty, the less prosperous and physically feebler portion of the community have something to do with their higher birth-rate, but they do not account for it to the extent of at least 50 per cent. To such extent a lesser absolute fertility, a lessened exercise of fertility, or a deliberate restraint of fertility, must exist in the classes of higher social status to account for the observed facts. Postponement of marriage is not the sole reason why the better element in the community has at present the lower birth-rate.

VIII. It remains now to consider whether the condition of affairs indicated in the previous sections is a permanent feature of our social structure, or a matter of comparatively recent growth. Unfortunately while our present census system is extraordinarily defective in data bearing on the sociological condition of the nation—compare, for example, some of the Australian information!—that of 50 years ago is still more defective. It was not possible to obtain the age distribution of the married women for the London districts in 1851, but I have been able to obtain the correlation between the birth-rate for 35 districts calculated on the married women aged 20 and upwards, and some five of the characters employed in the investigations of the later period. As has been stated, to make comparison possible, these characters have had their correlations for the later period recalculated on a birth-rate derived in the same manner. The results are given in Table IX.

TABLE IX. Comparison of Correlations of Birth-rate and Social Status in 1851 and 1901.

Character correlated with Birth-rate	Correlation coefficients	
	1851	1901
Number of Female domestic servants per 100 females ...	– ·630 ± ·069	– ·801 ± ·046
,, Professional men per 1000 males	– ·529 ± 082	– ·783 ± ·050
,, General labourers per 1000 males	+ ·120 ± ·112	+ ·518 ± ·095
,, Pawnbrokers, etc., per 1000 males	+ ·213 ± ·109	+ ·627 ± ·079
Mean arithmetical value...............	·373	·682
,, Children dying under 1 year per 1000 births	– ·296 ± ·104	+ ·506 ± ·097

This Table shews that we have for the first four categories the same general relationships between undesirable social conditions and a high birth-rate, *but that the intensity of this relationship has almost doubled in the fifty years.* It is scarcely possible to overrate the importance of this result for the grave problem of national degeneration. The causes which lead the poorer stocks of the community to reproduce at a greater rate than the better stocks have increased in effect during the last fifty years by nearly 100 per cent.

Another most important point is the change that has taken place in the relationship between infantile mortality and the birth-rate. This has changed from a correlation of $-{\cdot}296$ to one of $+{\cdot}506$. In 1851, districts where the wives had many children were those with the least infantile death-rate; in 1901 where the infantile mortality is greatest, there the fertility is greatest, or there has been an entire swing over in this relationship. Now it is well known that the birth registration was very incomplete until 1875, and we should naturally expect considerable irregularities in the correlation coefficients; we actually find that the correlation was sensibly negative in 1851, 1861, and 1871,—larger in the last two years than in 1851; in 1881 and 1891 it is still negative but practically insensible, while in 1901 it has become large and positive*.

When we consider that the correlation between

$$\frac{\text{Legitimate Births}}{\text{Number of married women}} \text{ and } \frac{\text{Deaths in first year of life}}{\text{Total Births}}$$

must of necessity have a large negative spurious component, it is the more remarkable that this correlation should now be markedly positive. There seems, however, no doubt that at present in those districts where there is greatest carelessness of child life, there the fertility is highest†.

Unfortunately we have not the data necessary for calculating the correlations of the mean age of the married women for the districts of 1851 with the social status of those districts. We cannot assume that these correlations would be the same as in 1901, but if we take it that the earlier marriage of the artizan classes has always been a factor, if to a less marked extent, of our national reproductivity, then it is not unreasonable as a first approximation to calculate out the partial correlation coefficients for 1851 on this assumption that these correlations have not changed largely. The results are given in Table X.

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[*] I hope to consider this point more fully in another paper dealing with other districts and larger intervals than the year, which is rather too short a period for the correlations to be free from irregularities due to local infantile epidemics.

[†] Some remarkable effects of economic legislation are reported to me from the Yorkshire woollen manufacturing district. Formerly children being employed in the factories were commercial assets and it was actually of the greatest importance to have not only a large family but to keep it in health. At present children have for a long period no commercial value; they are thus not only neglected but there are probably no districts where destruction of pre-natal life is more systematically carried out than in that referred to.

TABLE X. Effect of mean age of wives on coefficients of correlation in 1851 and 1901.

Character correlated with Birth-rate	Partial correlations	
	1851	1901
Female domestic servants per 100 females	+ ·156	− ·383
Professional men per 1000 males	+ ·345	− ·400
General labourers per 1000 males	− ·527	+ ·280
Pawnbrokers, etc., per 1000 males	− ·539	+ ·342

This Table is most suggestive. Every one of the 1851 correlations is now *reversed in sign*. In other words, if the influence of social status on age of wives had been of the same intensity as in 1901 it would *have more than accounted for* the observed correlations between low social status and high birth-rate. But we know from other considerations that the tendency to postpone marriage has really been more intensified in the upper than in the lower social classes during the past two generations*. We are thus driven to the almost certain conclusion that differences in the mean age of wives were amply sufficient in 1851 to account for the differential birth-rates of districts with divergent social status. On the other hand, in 1901, the districts with the lower social status had, in a much greater degree than in 1851, a higher birth-rate than those with higher social status, and at least 50 per cent. of this is not attributable to difference of age at marriage, but must be associated with a reduced fertility or a less exercised fertility in the wives of those with a higher social status. We conclude therefore that while in the last 50 years there has been 100 per cent. increase in the intensity of the relation between low social status and high birth-rate this increase has arisen from new causes. In 1851, the relationship could be accounted for by a relatively greater tendency to postpone marriage in the districts with higher social status. In 1901 this will not account for the observed facts; we have to deal with a reduced net fertility in the more cultured, the more prosperous, healthy and thrifty classes of the community which cannot be accounted for by the variation in the mean age of the possibly reproductive wives.

IX. *General Conclusions.*

I am fully aware of the limitations of the present study. It applies only to one city—if indeed the most important city of this country—but it was a case in which I could find information which, if it exists in other cases, is not so readily accessible. I shall be satisfied if this preliminary study indicates how the newer methods in statistics can be applied to problems which at the present moment are of the most vital national importance. Further studies will appear on this subject, but what is urgently needed is a permanent census bureau or at least a section of the Registrar-General's Department properly trained in modern methods, the function of which should be to prepare, from unpublished information of past censuses and registration reports, occasional investigations into special problems of national life. Such a department ought if possible to be associated with a system of periodic national anthropometric surveys. The work required to deal with possible sources of national degeneracy can only be superficially carried out by those who enquire as individuals and without access to special sources of information or the command of clerks and computators.

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* Thus I find that in 1861, the correlation between birth-rate and mean age of possibly reproductive wives was − ·494 ± ·083, as compared with − ·834 ± ·040 in 1901. Again the correlation of birth-rate and number of domestic servants is only − ·490 ± ·085 as against − ·802 ± ·046. The partial correlation coefficient is − ·208 as against − ·383 in 1901. We see accordingly that the influence of status on fertility has sensibly increased in the interval.

As far as the present investigation goes it demonstrates I think conclusively that for the London districts there is a very close relationship between undesirable social status and a high birth-rate. In districts where there is overcrowding, where there is a superabundance of the lowest type of labour, where it is needful to employ many young children in order to earn daily bread for the family, where infantile mortality is greatest, there the wives of reproductive ages have most children. Where there is more culture and education as shewn by a higher proportion of professional men, where there is more leisure and comfort as shewn by a higher percentage of domestic servants, where the traders who appeal to the improvident and thriftless are fewer in number, there the birth-rate is least. Again, where there is more general pauperism, where signs of bad environment like phthisis are prevalent, where pauper lunatics are most plentiful, there the birth-rate is highest. Cancer alone of the undesirable physical conditions dealt with so far seems more prevalent in the prosperous and cultured districts and to be associated with a lower birth-rate.

Nor is the higher birth-rate of the undesirable elements compensated by the higher death-rate. The net fertility of the lower status remains higher than that of the superior status.

The relationship between inferior status and high birth-rate has practically doubled during the last fifty years, and it is clear that in London at least the reduction in the size of families has begun at the wrong end of the social scale and is increasing in the wrong way. I have brought forward evidence enough to shew that the birth-rate of the abler and more capable stocks is decreasing relatively to the mentally and physically feebler stocks.

If we turn to find any special source of this decrease, we naturally appeal first to the postponement of marriage. This would almost certainly account for the whole observed state of affairs in 1851, but it can scarcely account for half of it in 1901. In fifty years there has been a most marked increase in the correlations between low status and high birth-rate, and this increase is certainly due to other factors than postponement of marriage. If we attribute even 50 per cent. of this to age at marriage it does not help us to modify the condition of affairs. Without being unduly alarmist, it is needful to reiterate that the following statements are substantially correct:

(*a*) 25 per cent. of the married population—and this is only a section of the whole adult population—produces 50 per cent. of the next generation.

(*b*) Physical and mental characters, tendencies to health and disease, intellectual and manual capacities, are undoubtedly inherited.

(*c*) A higher net fertility is shewn, under at any rate the present social conditions of a large city, to be very markedly correlated with most undesirable social factors.

Whatever criticism may be raised as to individual points, there is scarcely room for doubt that in the main the above statements may be taken as demonstrated. But if demonstrated, they indicate distinct sources of national deterioration which the statesman and social reformer must be prepared to consider, and consider quickly.

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